temperature rose above 100° and 14 years when the minimum temperature fell below 0°F.

The average temperature for the seasons is as follows: Winter, 31.6°; spring, 49.7°; summer, 72.3°; and fall, 52.5°.

January is the coldest month, with a mean temperature of 29.4°; but the lowest average monthly temperature is credited to February, 1903, which was 20°. The warmest month is July, whose mean is 75.4°.

There are 89 rainy days in Salt Lake City, and the average annual precipitation is 16.24 inches. The wettest year was 1875, when 23.04 inches were measured; the driest in 1890, 10.33 inches. April is normally the wettest month and July the driest. No excessive rainfall ever occurs in Salt Lake City. The greatest 24-hour amount was 2.72 inches, in May, 1901. The heaviest rain in one hour was 0.91 inch, on July 19, 1912. The average snowfall is 50.6 inches, most of which falls from December to March, inclusive.

In general, the climate is agreeable when one considers the effect of a year's experience. The warm summer days are accompanied by low humidities, followed by cool nights. The winter temperatures are sometimes quite low, but never for long periods.

CLIMATIC CONTROL OF CROPPING SYSTEMS AND FARM OPERATIONS

By J. F. VOORHEES.

[Author's abstract.]

The object of this paper is to prove that all successful cropping systems must be based on climatic conditions.

By cropping systems we refer to the number of crops that are grown successively on the same ground in one year, as a one-crop system or a two-crop system.

Climatic control may be positive or negative. Negative control is exercised when climate prevents us from growing more than a certain number of crops and when it permits us to grow a certain number of crops. Positive control is exercised when climate penalizes us for failure to grow as many crops as possible.

The climatic factors considered are rainfall, length of growing season, and heat intensity. Variations of these factors give us a great variety of climates, as the continuous-crop climate, the two-crop climate, the one-crop climate, and the no-crop climate.

Negative or preventive control is exercised in all but the continuous-crop climate, while positive control is exercised mainly in those regions where more than one crop can be grown.

Temperature controls our crop successions and our farm operations through control of the length of time required for the growth and maturity of both plant and insect life.

The penalty for failure to use a proper cropping system is loss of the farm. This is proved by the fact that many worn-out farms have been reclaimed by proper cropping systems.

To comply with the demands of climate more knowledge of the relationship between plants and animals on one side and climatic conditions on the other is needed. This knowledge can best be obtained through cooperation.

THE THUNDERSTORMS OF THE UNITED STATES AS CLIMATIC PHENOMENA.

By Prof. ROBERT DEC. WARD.

[Author's abstract.]

As essential characteristics of American climate, thunderstorms have a broad human interest. From the viewpoint of climatology, the distribution of thunderstorms is of more interest than their mechanism. The part played by their rains in watering our crops is of greater importance than the size of the raindrops. The damage done by their lightning and hail concerns us more than the cause of the lightning flash or than the origin of the hailstones. The thunderstorms of the eastern United States are among the most characteristic of American climatic phenomena. In size, intensity, and frequency of occurrence they are unique.

No part of the country is entirely free from thunderstorms, but the two regions of greatest activity are in Florida and in northern New Mexico. It is over the immense area east of the Rocky Mountains that our great State-wide thunderstorms occur, which often last for many hours, and may cover a territory stretching from the Mississippi Valley to the Atlantic coast. Throughout this area also, on hot summer afternoons, hundreds of scattering sporadic thunderstorms often occur, of local importance because supplying rain. These local storms are more frequent in southern than in northern sections, and as a whole the northern tier of States has distinctly fewer thunderstorms than the southern.

The thunderstorms of the mountains and plateaus of the West are chiefly sporadic and short-lived. They supply the rainfall of the higher elevations, commonly known as "islands" of rainfall, though obviously more appropriately termed "lakes." On the Pacific slope thunderstorms are not often experienced on the immediate coast, but occur more frequently in the interior valleys and on the mountains. They are characteristic summer phenomena at the greater elevations and furnish much or all of the "dry season" rainfall of those localities.

In relation to man's activities, it is of significance that most thunderstorms occur at the time of year and at hours when outdoor activities are at their height. The Southern States may be said to be in the thunderstorm belt all the year. As spring and summer come on, this belt moves northward. Taking the country as a whole, July brings most thunderstorms. Late spring and early summer bring considerable thunderstorm rainfall of marked economic importance over the eastern Rocky Mountain foothills and the Great Plains, while over the plateau region thunderstorms are most frequent in late summer. On the Pacific slope the inland thunderstorms show a preference for summer; the rarer ones of the immediate coast develop chiefly in winter.

A broadly generalized composite weather map is given, showing conditions under which "cyclonic" thunderstorms are likely to occur over the area from the Mississippi Valley eastward, and another map, also generalized, shows conditions favorable for the development of "heat" thunderstorms over the eastern United States.

Thunderstorms bring us much that is of benefit. To them we owe much, in parts of our country even most, of our spring and summer rainfall. Without these beneficent thunderstorms our great staple crops east of the Rocky Mountains would never reach maturity. One good thunderstorm over a considerable area at a critical crop stage is worth hundreds of thousands of dollars to American farmers. Our stock markets time and again show the favorable reaction of such conditions upon the prices of cereals and also of railroad and other stocks. Thundershowers break our summer droughts, cleanse our dusty air, refresh our parched earth, replenish our failing streams and brooks, bring us cool evenings and nights after sultry and oppressive days.

THE ECONOMIC ASPECT OF CLIMATOLOGY.

By EDWARD LANSING WELLS.

[Author's abstract.]

The economic status of the individual depends to a degree upon his environment and upon his ability to select a favorable environment or to make the most of that which is inevitable in his environment. Natural resources constitute a part of one's environment, and climate is an important natural resource.

Climate is intimately related to agriculture, engineering, transportation, commerce, manufacturing, health and efficiency, recreation, safety, and to practically every human activity.

It controls the distribution of vegetation, both as to kind and quantity, and successful agriculture depends upon a knowledge of climatology and how to make the best of existing conditions. Its relation to agriculture is indirect as well as direct, having to do with problems of irrigation, drainage, transportation, manufacturing, marketing, and the efficiency of labor, as well as with the control of insect pests and fungous diseases.

In engineering work climatology is of value in the development of water power and wind power, in the construction and maintenance of transmission lines, whether for power or for communication, in construction and operation of irrigation systems, in the construction of buildings, bridges, railroads, water-supply systems, sewers, and heating and refrigeration plants.

Few commodities are used where they are produced, and climatology enters largely into most of the problems of transportation. Sailing routes are laid out so as to take advantage of the great wind systems and to avoid storm tracks and fog areas. Floods, deep snows, high winds, etc., are to be considered in laying out railroads, and perishable freight must be protected in accordance with existing and expected weather conditions. Claims for damage to perishable freight and for car demurrage are often settled on the basis of weather records. Climate should be carefully considered in building and maintaining automobile roads.

The price of commodities, property, and labor depends to a certain extent upon supply and demand, and both supply and demand are affected by the climate. The prices of foodstuffs may vary rapidly under the influence of weather changes. Insurance rates are based, in part, upon the showing made by the weather records, and life insurance companies sometimes refuse policies to residents of States known to have an unhealthful climate. The distribution of many commodities, such as clothing and farming implements, is governed by the demands of the climate. Advertising, routing of salesmen, the location of distributing depots, and the pressing of collections depend upon weather conditions. The means of commercial communication are often good or bad, as the climate is favorable or unfavorable. In the storage of perishable products, studies of the climate are absolutely necessary. Conventions and fairs, having a commercial value to the localities where held, are attracted to places where the climate is known to be favorable.

Many manufacturing industries are regional because they demand certain climatological conditions. Among these may be mentioned the manufacture of tobacco products and textiles. The character of the

manufactured product is sometimes varied to suit the climate where the product is to be used, as in the case of prepared paints. Factories are sometimes located where water power may be obtained or where raw material is abundant, and both these conditions are peculiarly related to the climate.

Health and the personal attributes usually accompanying health all have an economic value, and these are dependent to a certain extent upon climate, either as climate affects the individual directly or as it brings about other conditions favorable or unfavorable for health. Often the climatological conditions affecting health are extremely local. The congregation of large numbers of health seekers in a region known to possess a healthful climate is a commercial asset to such a region. The efficiency of labor is reduced by a climate which is unfavorable for outdoor work.

Many forms of amusement and recreation have been commercialized, and of these a number are of such character as to group themselves naturally in certain climatological zones. Tourist travel is being deflected from its former lines and will be an increasing source of revenue to those sections known to have good scenery, good roads, and good climate. The industry of staging photoplays has become a regional one, owing to the favorable climate of certain sections.

There are certain meteorological phenomena that are much dreaded, and regions known to be free from these phenomena attract population because of such freedom. In such varied enterprises as the study of astronomy, the conservation and restoration of the forests, and the adjudication of cases at law, climatology plays a part, and in fact there is scarcely a human activity to which it is not related.

There are few lines of scientific investigation which promise greater return from an economic standpoint.

THE MEANING OF THE WORD "FAIR" IN METEOROLOGY.

By ELEANOR BUYNITZKY.

[Dated: Weather Bureau Library, Washington, Feb. 2, 1916.]

The meaning of the word "fair," as applied by meteorologists to weather conditions, has varied somewhat from time to time. In this country it was formerly used in recording the state of the sky, with reference to the degree of cloudiness. To-day, however, both in the United States and England, it is employed by meteorologists principally in connection with forecasts, to denote absence of precipitation.

The general dictionaries published in the United States have made some attempt to recognize the technical definitions of this term, as shown by the following quotations:

Century Dictionary.—Comparatively favorable or propitious; not obstructive or forbidding; moderately fit or suitable: as, *fair* weather (as distinguished from clear or foul weather). In the weather reports of the United States Signal Corps, the sky is said to be *fair* when it is from four-tenths to seven-tenths (inclusive) covered with clouds.—*Report of Chief Signal Officer for 1881, p. 745.*

New Standard Dictionary.—Having the sky from four- to seven-tenths covered with clouds: said of the weather, and distinguished from *clear*.

Webster's New International Dictionary.—Free from rain, hail, or snow; so used in the predictions issued by the United States Weather Bureau. The weather may be cloudy or threatening, but if no precipitation occurs it is called fair.

The old Signal Service definition found in both the Century and the Standard dictionaries has not been in official use since 1888, so far as the *regular* observers of the service are concerned, although the word "fair" in the sense "partly cloudy" was employed by *voluntary* observers until some years later. This was probably due to the fact that, for some unknown reason, the "Instructions for Voluntary Observers," published by the Weather Bureau in 1892, retained the old definition of the term, notwithstanding the fact that a Signal Service order had been issued four years earlier, substituting "partly cloudy" for "fair" in the various forms and reports of the service and stating specifically that "the term 'fair' will be construed in the Signal Service publications to mean absence of precipitation." (See list of definitions below.)

Reference is made to the official use of the word "fair" in the Report of the Chief Signal Officer for the year 1870, page 20, in connection with certain forms used by the "Division of Telegrams and Reports for the Benefit of Commerce." The term is not defined, but the context indicates that it was used to mean "partly cloudy" or "cloudy," without rain. A similar use of the word is also shown in the "Instructions to Observer Sergeants," Signal Service, 1871, page 15. Its history in the meteorological service of this country may be further traced in the following quotations taken from the "Instructions," etc., of the Signal Service and the Weather Bureau:

1875. U. S. Signal Service. Instructions to Observer Sergeants, 1875, p. 52:

In deciding whether a day is clear, fair, or cloudy, its character will be determined by taking the sum of the entire number of fourths of clouds observed at 7 a. m., 2 p. m., and 9 p. m. A clear day will be one in which the sum of the observed fourths is three or less than three; a fair day, one in which the sum is from four to eight, inclusive; and a cloudy day, one for which the sum is from nine to twelve, inclusive.

1881. U. S. Signal Service. Instructions to Observers, 1881 [replacing all former editions and amendatory orders up to and including June 14, 1881], p. 63:

The state of the weather will be determined as follows: *Clear*, when the sky is three-tenths or less than three-tenths covered with clouds; *fair*, when the sky is from four-tenths to seven-tenths (inclusive) covered; *cloudy*, when the sky is more than seven-tenths covered.

1881. U. S. Signal Service. Instructions to Special Observers in the Cotton Belt [published in connection with Signal Service Orders No. 55, July 14, 1881], p. 7:

In recording the state of the weather, at the time of observation, the following characterizations must be used:

"Clear," when the sky is less than one-fourth covered with clouds.

"Fair," "$\frac{1}{4}$ cloudy," "$\frac{2}{4}$ cloudy," and "$\frac{3}{4}$ cloudy," according to the amount of clouds observed at the time of observation.

"Cloudy," when the sky is more than three-fourths obscured by clouds.

1888. U. S. Signal Office. General Orders, No. 54, December 21, 1888, p. 1:

On and after January 1, 1889, the term "fair" will be construed in the Signal Service publications to mean absence of precipitation. The use of the word "fair," in the various forms and reports of the Service, to indicate partly cloudy weather will be discontinued and replaced by "partly cloudy."

1892. U. S. Weather Bureau. Office Instructions, No. 3, February 15, 1892 [effective January 1, 1892], p. 1:

Forecasts of fair weather will be considered to indicate the absence of rainfall in excess of 0.01 of an inch.

1892. U. S. Weather Bureau. Instructions to Voluntary Observers, by T. Russell, 1892, p. 60:

The weather is recorded clear when the sky is $\frac{3}{10}$ or less obscured; fair, when the sky is from $\frac{4}{10}$ to $\frac{7}{10}$ obscured; cloudy, when the sky is more than $\frac{7}{10}$ obscured; light rain (*lt. r.*), when there is light rain; [etc.].

1895. U. S. Weather Bureau. Instructions for Observers, 1895, p. 32:

In forecasting weather, the term "fair" is used to indicate that no precipitation in excess of 0.01 of an inch is anticipated.

1897. U. S. Weather Bureau. Instructions, No. 61, August 2, 1897, p. 2:

Forecasts of fair weather will be considered to indicate the absence of rainfall in excess of 0.01 of an inch.

1905. U. S. Weather Bureau. Station Regulations, 1905, paragraph 280:

Forecasts of "fair," "partly cloudy," or "cloudy" will be made when precipitation to the amount of 0.01 inch or more is not expected.

This was amended, October 1, 1905 (see Appendix to the 1905 Regulations, paragraph 8), to read as follows:

Forecasts of fair weather will be verified when precipitation in excess of 0.01 of an inch does not occur.